Ref. 2

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(21)Application number : 08-291076 (71)Applicant : TEXAS INSTR JAPAN LTD

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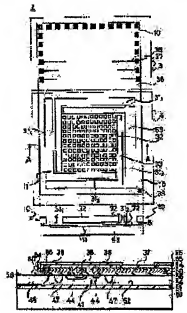
(54) COMPOSITE DEVICE MANUFACTURE AND COMPOSITE DEVICE



(57)Abstract:

PROBLEM TO BE SOLVED: To provide a technique which can make the electrode of a composite device without using the lift-off method.

SOLUTION: When forming a composite device 2 by forming a patterned mask film 66 by using water having a sacrifice layer 51, and patterning a structure layer 54, and etching the sacrifice layer 51 from the exposed place, and forming a mover 11 at the section where the sacrifice layer 51 is removed, and forming a fixed body 10 at the section where the sacrifice layer 51 is left, a metallic film 60 is made and patterned and an electrode 37 for electric connection with outside is made in advance before forming the mask film 66. A passivation film (titanium tungsten film) 64 is made in advance on the surface of the metallic thin film 60, and at the time of etching of the sacrifice layer 51, the metallic film 60 is protected. It will do without using the lift-off method, and also the thin film wiring 38 and the electrode 37 can be made of the same metallic film 60.

Ref-2

対応なし、英抄

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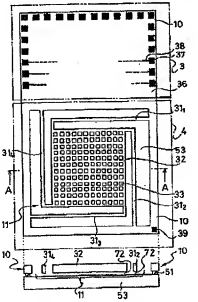
(54)【発明の名称】　複合デバイス製造方法、及び複合デバイス

(57)【要約】
【課題】リフトオフ法を用いずに複合デバイスの電極を形成できる技術を提供する。
【解決手段】犠牲層５１を有するウェハー５０を用い、パターニングしたマスク膜６８を形成して構造層５４をパターニングし、露出したところから犠牲層５１をエッチングし、その犠牲層５１を除去した部分で可動体１１を形成し、犠牲層５１を残した部分で固定体１０を形成して複合デバイス２を製造する際、マスク膜６８を形成する前に金属薄膜６０を形成してパターニングし、外部との電気的接続用の電極３７を形成しておく。その金属薄膜６０表面に保護膜(チタン・タングステン薄膜)６４を形成しておき、犠牲層５１のエッチングの際に金属薄膜６０を保護する。リフトオフ法を用いなくても済み、また、薄膜配線３８と電極３７とを同じ金属薄膜６０で形成できる。



1

【特許請求の範囲】

【請求項１】　犠牲層を介して基板上に形成された構造層上にパターニングされたマスク膜を形成する工程と、そのマスク膜をマスクに用いて前記構造層をエッチングして前記犠牲層を露出する工程と、

前記露出した部分から前記構造層下面の犠牲層をサイド・エッチングを有するエッチングにより除去する工程とを有し、

前記構造層のうち、底面下の犠牲層を完全に除去した部分で可動体を形成し、底面下の犠牲層を残した部分で固定体を形成する複合デバイスの製造方法であって、

前記マスク膜を形成する前に、

前記固定体を構成する構造層中に電気素子を構成する工程と、

前記構造層上に少なくとも外部接続用の電極を含む金属薄膜を形成する工程と、

該金属薄膜をパターニングする工程とを有することを特徴とする複合デバイスの製造方法。

【請求項２】　前記金属薄膜を形成した後、前記マスク膜を形成する前に、前記電極表面に保護膜を形成しておき、前記犠牲層をエッチングする際に前記電極がエッチングされないようにしたことを特徴とする請求項１記載の複合デバイスの製造方法。

【請求項３】　前記保護膜を形成した後、前記マスク膜を形成する前に、前記保護膜上にパターニングしたパッシベーション膜を形成しておくことを特徴とする請求項２記載の複合デバイスの製造方法。

【請求項４】　前記パターニングしたパッシベーション膜をマスクとし、前記電極上の前記保護膜を除去することを特徴とする請求項３記載の複合デバイスの製造方法。

【請求項５】　前記金属薄膜をパターニングする際に、その金属薄膜によって前記電気素子を互いに接続する金属配線を形成することを特徴とする請求項１乃至請求項４のいずれか１項記載の複合デバイスの製造方法。

【請求項６】　前記基板を導電性基体上に固定し、前記基板の裏面から前記導電性基体への電気的接続を行えるようにしたことを特徴とする請求項１乃至請求項５のいずれか１項記載の複合デバイスの製造方法。

【請求項７】　前記構造層及び前記基板はシリコン基板であり、前記犠牲層はシリコン酸化膜であることを特徴とする請求項１乃至請求項６のいずれか１項記載の複合デバイスの製造方法。

【請求項８】　前記パッシベーション膜は窒化シリコン膜であることを特徴とする請求項４乃至請求項７のいずれか１項記載の複合デバイスの製造方法。

【請求項９】　犠牲層が基板と構造層との間に位置するウェハーの、前記構造層がパターニングされた後、前記犠牲層がエッチングされ、

前記構造層の内、底面下の犠牲層が完全に除去された部

2

分で可動体が形成され、底面下の犠牲層が残された部分で固定体が形成された複合デバイスであって、

前記構造層上に形成されたパターニングされた金属薄膜によって薄膜配線及び外部接続用の電極とが設けられ、前記金属薄膜上に保護膜が形成されるが、前記犠牲層のエッチング後、少なくとも前記電極上の前記保護膜が除去されることを特徴とする複合デバイス。

【請求項１０】　前記固定体を構成する構造層中には電気素子が設けられ、前記薄膜配線によって互いに電気的に接続されていることを特徴とする請求項９記載の複合デバイス。

【請求項１１】　導電性基体を有し、前記基板が前記導電性基体に固定された複合デバイスであって、

前記基板の裏面から前記導電性基体への電気的接続を行えるように構成されたことを特徴とする請求項９又は請求項１０のいずれか１項記載の複合デバイス。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、複合デバイスとその製造方法にかかり、特に、マイクロマシーンと回路素子とを備えた複合デバイスにおいて、そのマイクロマシーンを形成するときの犠牲層のエッチングの際、回路素子における金属薄膜が保護膜で保護された複合デバイスとその製造方法に関する。

【０００２】

【従来の技術】近年では、シリコンマイクロマシーニング技術が広く用いられており、例えば加速度センサーや角速度センサーに適用され、微細なセンサー素子がシリコン半導体基板上に作成されている。

【０００３】そのようなシリコンマイクロマシンの一例として、図５の特開１００ＫＩ加速度センサーを示す。

【０００４】この加速度センサー１００は、シリコン基板１０３上に形成された、マス部１２２と、アーム１２１$_1$～１２１$_4$と、固定体１２０$_1$～１２０$_4$とを有している。マス部１２２は矩形形状に成形されており、その四隅には、アーム１２１$_1$～１２１$_4$の一端が接続され、各アーム１２１$_1$～１２１$_4$の他端は各固定体１２０$_1$～１２０$_4$に接続されている。

【０００５】固定体１２０$_1$～１２０$_4$はシリコン基板１０３上に固定され、他方、マス部１２２とアーム１２１$_1$～１２１$_4$は、基板１０３と接触しないように移動自在に構成されており、加速度センサー１００が上下方向に加速度移動をし、マス部１２２に力が加わったときに、固定体１２０$_1$～１２０$_4$を支点としてアーム１２１$_1$～１２１$_4$が上下に撓み、マス部１２２と基板１０３とで構成される平行平板コンデンサの容量が変化するように構成されている。

【０００６】このような加速度センサー１００の製造工程を、図６(a)～(e)、図７(f)～(j)に簡略化して示し、以下に説明する。

【0007】図6(a)～(e)を参照し、先ず、表面にシリコン酸化膜が形成された2枚のシリコン単結晶基板を用意し、そのシリコン酸化膜同士を密着させて直接接合法によって接合し、一枚のシリコンウェハーを形成する。次いで、一方のシリコン単結晶の熱酸化膜が形成された側と反対側の面を研磨して構造層１０４とし、他方のシリコン単結晶層はそのままにして基板１０３とする。その基板１０３と構造層１０４との間には、直接接合に用いたシリコン酸化膜が犠牲層１０１として残されている(図9(a))。

【0008】このようなシリコンウェハーの構造層１０４表面に酸化膜１０５を全面成膜し(同図(b))、所定領域をエッチングすることによりパターニングして開口部１０７を形成する(同図(c))。

【0009】この開口部１０７底面にはシリコン構造層１０４表面が露出しており、エッチングせずに残した酸化膜１０５をマスクとし、ＲＩＥ法によって異方性ドライエッチングを行うことにより、前記開口部１０７底面に露出した構造層１０４がエッチング除去され、構造層１０４が残った酸化膜１０５のパターンと同じパターンにパターニングされる(同図(d))。

【0010】そのパターニングが終了したときは、開口部１０７底面には犠牲層１０１が露出しており、ウェットエッチングを行うと、構造層１０４のパターニングに用いた酸化膜１０５と開口部１０７底面に露出した犠牲層１０１が除去される(同図(e))。

【0011】その状態で、イオンインプランテーションと熱拡散とを行うと、基板１０３と構造層１０４の表面に露出した部分にオーミック層１１３、１１４がそれぞれ形成される(図10(f))。

【0012】次いで、全面にレジスト膜１１５を形成し(同図(g))、オーミック層１１３、１１４上の所定部分を窓開けした後、クロム・白金の蒸着を行うと、レジスト膜１１５上とオーミック層１１３、１１４上に、クロム・白金薄膜１１６、１１７、１１８がそれぞれ形成される(同図(h))。

【0013】この状態からレジスト膜１１５の剥離を行うと、レジスト膜１１５上に形成されたクロム・白金薄膜１１８はレジスト膜１１５と一緒に除去される(リフトオフ法)。他方、オーミック層１１３、１１４上に形成されたクロム・白金薄膜１１７、１１８は除去されずに残り、基板１０３と固定体１２０,にそれぞれ金属電極が形成される(同図(i))。

【0014】さらに、全体をフッ酸緩衝液(ＢＨＦ)に浸漬すると、犠牲層１０１の側面は露出しているから、犠牲層１０１はその側面からエッチングされる。このとき、構造層１０４のうち、面積が大きいか、又は幅が広い部分では、その底面下にある犠牲層１０１は残される。従って、その部分の構造層１０４は犠牲層１０１によって基板１０３に固定されており、固定体１２０,～１２０,が形成される。

【0015】他方、構造層１０４のうち、面積が小さいか、又は幅が狭い部分では、底面下の犠牲層１０１は完全に除去されてしまう。従って、その部分の構造層５４を固定体を構成する構造層と接続しておけば、基板１０３との間に空間７２が形成され、基板１０３と非接触な可動体が構成される。アーム１２１,～１２１,とマス部１２２はそのような可動体として構成されている。

【0016】このとき、マス部１２２とアーム１２１,～１２１,とは、基板１０３と接触しない状態で固定体１２０,～１２０,によって支持されており、加速度が加わったときにアーム１２１,～１２２,はマス部１２２の重量によって撓み、基板１０３とマス部１２２との間の距離が変化する。

【0017】従って、電極１１７、１１８に金属細線をワイヤーボンディング接続し、マス部１２２と基板１０３とを図示せぬ外部の測定回路に接続すると、マス部１２２と基板１０３との間の容量変化を検出し、加速度の大きさを算出することが可能となる。

【0018】しかしながら上述したように、従来技術ではクロム、白金薄膜１１８の形成にリフトオフ法を用いるため、工程が複雑であり、しかも、そのリフトオフ法を用いるためには、集積回路中の層膜配線を構成するアルミニウム薄膜では電極１１７、１１８を形成できず、回路素子とマイクロマシンとを同一基板上に形成する際の障害となっていた。

【0019】

【発明が解決しようとする課題】本発明は上記従来技術の不都合を解決するために創作されたもので、その目的は、リフトオフ法を用いずに複合デバイスの電極を形成できる技術を提供することにある。

【0020】

【課題を解決するための手段】上記課題を解決するために、請求項１記載の発明方法は、犠牲層を介して基板上に形成された構造層上にパターニングされたマスク膜を形成する工程と、そのマスク膜をマスクに用いて前記構造層をエッチングして前記犠牲層を露出する工程と、前記露出した前記犠牲層から前記構造層下面の犠牲層をサイド・エッチングを有るエッチングにより除去する工程とを有し、前記構造層のうち、底面下の犠牲層を完全に除去した部分で可動体を形成し、底面下の犠牲層を残した部分で固定体を形成する複合デバイスの製造方法であって、前記マスク膜を形成する前に、前記固定体を構成する構造層中に電気素子を構成する工程と、前記構造層上に少なくとも外部接続用の電極を含む金属薄膜を形成する工程と、該金属薄膜をパターニングする工程とを有することを特徴とする。

【0021】この場合、請求項２記載の発明方法のように、前記金属薄膜を形成した後、前記マスク膜を形成する前に、前記電極表面に保護膜を形成しておき、前記構

5　　6

牲層をエッチングする際に前記電極がエッチングされないようにするとよい。

【0022】その請求項2記載の複合デバイスの製造方法では、請求項3記載の発明方法のように、前記保護膜を形成した後、前記マスク膜を形成する前に、前記保護膜上にパターニングしたパッシベーション膜を形成しておくことができる。

【0023】更に、その請求項3記載の複合デバイスの製造方法では、請求項4記載の発明方法のように、前記パターニングしたパッシベーション膜をマスクとし、前記電極上の前記保護膜を除去するとよい。

【0024】このような、請求項1乃至請求項4のいずれか1項記載の複合デバイスの製造方法では、請求項5記載の発明方法のように、前記金属薄膜をパターニングする際に、その金属薄膜によって前記電気素子を互いに接続する金属配線を形成するとよい。

【0025】また、請求項1乃至請求項5のいずれか1項記載の複合デバイスの製造方法では、請求項6記載の発明のように、前記基板を導電性基体上に固定し、前記基板の裏面から前記導電性基体への電気的接続を行えるようにするとよい。

【0026】さらにまた、請求項1乃至請求項6のいずれか1項記載の複合デバイスの製造方法では、請求項7記載の発明方法のように、前記構造層及び前記基板はシリコン基板であり、前記犠牲層はシリコン酸化膜であると都合がよい。

【0027】なお、請求項4乃至請求項7のいずれか1項記載の複合デバイスの製造方法については、請求項8記載の発明方法のように、前記パッシベーション膜は窒化シリコン膜であると都合がよい。

【0028】他方、請求項9記載の発明装置は、犠牲層が基板と構造層との間に位置するウェハーの、前記構造層がパターニングされた後、前記犠牲層がエッチングされ、前記構造層の内、底面下の犠牲層が完全に除去された部分で可動体が形成され、底面下の犠牲層が残された部分で固定体が形成された複合デバイスであって、前記構造層上に形成されたパターニングされた金属薄膜によって薄膜配線及び外部接続用電極とが設けられ、前記金属薄膜上に保護膜が形成されるが、前記犠牲層のエッチング後、少なくとも前記電極上の前記保護膜が除去されることを特徴とする。

【0029】この請求項9記載の複合デバイスでは、請求項10記載の発明装置のように、前記固定体を構成する構造層中に電気素子を設け、前記薄膜配線によって互いに電気的に接続しておくとよい。

【0030】また、請求項9又は請求項10のいずれか1項記載の複合デバイスが導電性基体を有し、前記基板が前記導電性基体に固定されている場合には、請求項11記載の発明装置のように、前記基板の裏面から前記導電性基体への電気的接続を行えるように構成しておくと部合がよい。

【0031】上述した本発明の構成によれば、犠牲層を介して基板上に形成された構造層上にマスク膜を形成し、そのマスク膜をマスクに用い、構造層をエッチングして犠牲層を露出させ、その露出した部分から構造層底面下の犠牲層をサイド・エッチングによって除去し、構造層のうち、底面下の犠牲層を完全に除去した部分で可動体を形成させ、底面下の犠牲層を残した部分で固定体を形成させるので、可動体と固定体とでマイクロマシンを構成させることができるが、前述のマスク膜を形成する前に、固定体を構成する構造層中に電気素子を構成させ、構造層上に少なくとも外部接続用の電極を含む金属薄膜を形成し、その金属薄膜をパターニングすると回路を構成することができるので、リフトオフ法を用いなくても同一基板中にマイクロマシンと回路とを形成させることができる。

【0032】その際、金属薄膜を形成する後、マスク膜を形成する前に、電極表面に保護膜を形成しておき、犠牲層をエッチングする際に電極がエッチングされないようにしておくと、外部との電気的接続用の電極表面が荒らされることがなくなり、品質の良い電極が形成できる。

【0033】また、保護膜を形成した後マスク膜を形成する前に、保護膜上にパターニングしたパッシベーション膜を形成しておくと複合デバイスの信頼性が向上して好ましい。そのパッシベーション膜は犠牲層を除去する際にエッチングされないものがよく、その場合には、パターニングされたパッシベーション膜をマスクとして保護膜を除去することが可能である。

【0034】さらにまた、金属薄膜をパターニングする際に、その金属薄膜によって電気素子を互いに接続する金属配線を形成しておくと、構造層のパターニングと犠牲層の除去の他は、通常の集積回路製造の工程で複合デバイスを製造することができる。

【0035】また、基板をリードフレーム等の導電性基体に固定する際、基板の裏面からその導電性基体との電気的接続を行えるようにしておくと、基板表面に電極を形成しなくても、可動体と基板とで構成されるコンデンサの電気的接続を行うことが可能となる。

【0036】なお、上述の構造層及び基板がシリコン基板で構成され、犠牲層がシリコン酸化膜で構成されるようにしておけば、製造が容易であり、コストが低くて済む。また、パッシベーションマクを窒化シリコン膜にしておくと、製造が容易になる。

【0037】

【発明の実施の形態】本発明の実施の形態を図面を用いて説明する。図1に、本発明の一例の複合デバイス2の平面図と、そのA－A線断面図を示す。

【0038】この複合デバイス2は、シリコン半導体である基板53を有しており、その基板53上に、回路部

3とマイクロマシン部４とが設けられている。

【００３９】マイクロマシン部４は、図５に示したセンサー１００と同様の構造の加速度センサーであり、基板５３に対して移動可能な可動体１１と、固定された固定体１０とを有している。

【００４０】この加速度センサーは、幅の狭いアーム３１$_1$～３１$_n$と、大面積で小孔３３がマトリックス状に形成されたマス部３２とを有しており、アーム３１$_1$～３１$_n$の一端は固定体１０に接続され、他端は可動体１１で構成されたマス部３２に接続され、各アーム３１$_1$～３１$_n$と固定体１０とによってマス部３２を支持するように構成されている。

【００４１】アーム３１$_1$～３１$_n$の底面とマス部３２の底面には、空隙７２が形成されており、従って、マス部３２と基板５３とは非接触の状態にあり、加速度が加わるとマス部３２の重量によって各アーム３１$_1$～３１$_n$が撓み、マス部３２が上下方向に移動できるように構成されている。

【００４２】従って、アーム３１$_1$～３１$_n$とマス部３２とは可動体１１によって構成されており、マス部３２と基板５３とによって構成される平行平板型のコンデンサは、マス部３２が上下移動すると容量値が変化するようにされている。

【００４３】他方、回路部３は固定体３６を構成する構造層中に形成された多数の電気素子を有しており、それらの電気素子によって測定回路が形成されている。

【００４４】また、回路部３内には、金属薄膜のパターニングにより形成された多数の外部接続用の電極である電極パッド３７と、電気素子間の電気的接続や、電気素子と電極パッド３７との間の電気的接続を行う薄膜配線３８が設けられており、マス部３２はその薄膜配線３８を介して前述の測定回路に接続され、その測定回路がマス部３２と基板５３とで形成されるコンデンサの容量変化を検出できるように構成されている。

【００４５】このような複合デバイス２の構造を、図２(a)～(e)、図３(f)～(i)、図４(j)～(m)を参照し、その製造方法と共に説明する。尚、その断面構造においては、図１に示した回路部３’及びマイクロマシン部４’のそれぞれの要部の一部分のみを示す。

【００４６】先ず、表面にシリコン酸化膜が形成された２枚のシリコン単結晶ウェハーを用意する。一方のシリコン単結晶ウェハー内には、そのウェハーとは反対の導電型の拡散層５２が所定領域に形成されており、シリコン酸化膜は、その拡散層５２が形成されている側の表面に形成されている。

【００４７】そのような２枚のシリコン単結晶ウェハーのシリコン酸化膜同士を密着させ、直接接合法により１枚のウェハー５０を形成する。

【００４８】その後、拡散層５２が形成された方のシリコン単結晶層を研磨して所定厚みまで薄くし、表面の構造層５４とする。他方はそのままの状態で基板５３を構成させる。また、直接接合の際に用いたシリコン酸化膜は犠牲層５１とする。

【００４９】このウェハー５０に対し、集積回路製造に用いる通常の半導体プロセスを適用し、バイポーラ・トランジスタを含む電子回路素子群を形成する。その一部を図中に示すと、構造層５６上に薄いシリコン熱酸化膜５６を形成した後、回路部となる構造層５４(符号３’で示す領域)の中に複数の拡散層４４を設け(拡散層４４は、図なる導電型のものも含む)、多数の電気素子４１を形成しておく(同図(b))。

【００５０】このとき、マイクロマシン部となる構造層５４(符号４’で示す領域)の中には、構造層５４と同じ導電型の拡散層４５を、構造層５４の厚みと同程度の深さに拡散させておく。また、回路部となる構造層５４中には分離膜４７を設け、拡散層５２と共に各電気素子４１を電気的に分離させておく。

【００５１】その状態では、構造層５４表面にはシリコン酸化膜から成る絶縁膜５６が形成されており、その絶縁膜５６をパターニングし、電気素子４１上とマイクロマシン部となる構造層５４上の所定位置に開口部５７、５８をそれぞれ形成する(同図(c))。

【００５２】その状態で、スパッタリング法によってアルミニウム薄膜から成る金属薄膜６０を全面成膜し(同図(d))、その金属薄膜６０の表面にチタン・タングステン薄膜から成る保護膜６４を続けて全面成膜する(同図(e))。

【００５３】次に、保護膜６４と金属薄膜６０とを一緒にパターニングし、面積が大きい矩形形状の電極パッド３７と幅の狭い薄膜配線３８とを形成する。このとき、可動体１１となる構造層５４上の保護膜６４と金属薄膜６０は除去しておく。

【００５４】薄膜配線３８は、開口部５７、５８を介して、拡散層４５や拡散層４４に電気的に接続させると、薄膜配線３８によって、電気素子４１同士の間や、電気素子４１と電極パッド３７との間が確実的に接続される。また、その薄膜配線３８によって、マイクロマシン部の可動体１１を電気素子４１や電極パッド３７に電気的に接続させることができる(図３(f))。

【００５５】その状態から、表面にシリコン窒化膜から成るパッシベーション膜６７を堆積し(同図(g))、次いで、マイクロマシン部上と電極パッド３７上のパッシベーション膜６７を除去すると、マイクロマシン部上では絶縁膜５６が露出し、電極パッド３７上では保護膜６４が露出する(同図(h))。

【００５６】その表面にシリコン酸化膜から成るマスク膜６８を堆積させると、マイクロマシン部内の構造層５４上では、そのマスク膜６８は、同じくシリコン酸化膜から成る絶縁膜５８上に形成される。また、マスク膜６８は、回路部内の電極パッド３７上ではチタン・タング

ステン薄膜から成る保護膜６４上に形成され、他方、他の回路部内の部分では塗化シリコン膜から成るパッシベーション膜６５上に形成される(同図(ｉ))。

【００５７】次に、マスク膜６６と絶縁膜５６とのパターニングを一緒に行い、マイクロマシン部内に開口部７０を形成すると、その開口部７０底面にはシリコン構造層５４表面(拡散層４５)が露出する(同図(ｊ))。

【００５８】開口部７０以外の領域の表面はマスク膜６６が位置しており、そのマスク膜６６をマスクに用いて異方性エッチングを行うと、開口部７０底面に露出している構造層５４がエッチングされる。その異方性エッチングは、開口部７０の底面に犠牲層５１表面が露出したところで停止する(同図(ｋ))。このような開口部７０からの構造層５４のエッチングにより、アーム３１，～３１，やマス部３２を構成する構造層５４が成形される。

【００５９】次いで、全体をフッ酸緩衝液(ＢＨＦ)に浸漬すると、開口部７０の底面から犠牲層５１のエッチングが開始される。そのエッチングは犠牲層５１の横方向にも進行し(サイドエッチング)、構造層５４の底面にある犠牲層５１は側面から浸食される。

【００６０】このとき、構造層５４のうち、小面積、又は幅狭に形成された部分では、その底面下の犠牲層５１が完全に除去されるが、大面積、又は幅広に形成された部分では、構造層５４の底面下に犠牲層５１が残り、その部分の構造層５４は犠牲層５１によって基板５３に固定される。このような大面積、又は幅広に形成された構造層５４とその底面の犠牲層５１によって固定体１０が構成される。

【００６１】小面積、又は幅狭に形成された構造層５４を、固定体１０を構成する構造層５４に接続しておくと、底面下の犠牲層５１が除去されたところでは、構造層５４と基板５３との間で空隙７２が形成され、その部分の構造層５４によって可動体１１が構成される(同図(ｌ))。

【００６２】前述のアーム３１，～３１，の構造層５４は幅が狭く、その一端は、固定体１０を構成する構造層５４に接続されているので、アーム３１，～３１，は犠牲層５１が除去されており、可動体１１によって構成されている。

【００６３】前述したように、アーム３１，～３１，の他端はマス部３２の四隅に接続されており、マス部３２の構造層５４には、小孔３３となる開口部７０がマトリックス状に配置され、構造層５４自体の幅は狭くされ、底面下の犠牲層５１は除去されるので、マス部３２は可動体１１によって構成される。

【００６４】このように、犠牲層５１のエッチングによって固定体１０と可動体１１とを形成する際、犠牲層５１と同じくシリコン酸化膜で構成されたマスク膜６６も一緒に除去されるので、回路部の薄膜配線３８上では、表面にパッシベーション膜６５が露出し、電極パッド３７上では保護膜６４が露出する。マイクロマシン部では、マスク膜６６の除去により、絶縁膜５８が露出するが、その絶縁膜５８はシリコン酸化膜で構成されているので、絶縁膜５６も除去されてしまい、構造層５４の表面(拡散層４５)が露出する。

【００６５】犠牲層５１をエッチングした後、全体を過酸化水素水に浸漬すると電極パッド３７表面に露出した保護膜６４が除去され、金属薄膜６０が表面に露出する(同図(ｍ))。

【００６６】その後、基板８０を、基板５３の裏面との電気的接続を有する状態でリードフレーム等の導電性基体８０上に固定し、導電性基体８０のリードと電極パッド３７とをワイヤーボンディングによって接続すると、基板５３とマス部３２とで構成されるコンデンサが、同じ基板５３上に形成された回路部３内の測定回路に接続された複合デバイス２を得ることができる。

【００６７】この場合、導電性基体８０と電極パッド３７とをワイヤーボンディングをせず、導電性基体８０とリード等をワイヤーボンディングしてもよい。

【００６８】前述の薄膜配線３８は回路部３内に形成したが、図１の符号３９で示すように、マイクロマシン部４内に形成してもよい。その場合マイクロマシン部４内の電極３９は、薄膜配線３８を介して拡散層４５と電気的に接続させ、又は拡散層４５に直接接続させてマス部３２と電気的に接続してもよいし、薄膜配線３８によって回路部３内の測定回路に接続し、その電極として用いてもよい。

【００６９】以上は、電気素子４１をｐｎ接合で分離させたが、誘電体分離等の種々の分離方法によるものも本発明に含まれる。また、回路部３内に形成する電気素子４１は、バイポーラトランジスタ、ＭＯＳトランジスタ、抵抗素子、コンデンサ等の電気素子が広く含まれる。

【００７０】また、以上は、可動体と基板との間で形成されるコンデンサーの容量変化を検出する加速度センサーの複合デバイスについて説明したが、本発明はそれに限定されるものではない。例えば、可動体と固定体との間で形成されるコンデンサーの容量変化を測定する複合デバイスや、その他センサー以外のマイクロマシンを有する複合デバイスを広く含む。

【００７１】上記実施例は、薄膜配線３８を介して可動体１１の構造層５４と電気素子４１とを接続したが、構造層５４中の拡散層によって接続させてもよい。

【００７２】上述の保護膜６４にはチタン・タングステン薄膜を用い、マスク膜６６にはシリコン酸化膜を用いたが、それに限定されるものではない。保護膜６４は、犠牲層５１を除去する際に、そのエッチング溶液(本例ではフッ酸緩衝溶液)によって除去されない薄膜であればよいが、チタン・タングステン薄膜を保護膜６４とした場合には、そのエッチング溶液である過酸化水素水

11

は、シリコン窒化膜等の通常のパッシベーション膜をエッチングしないので都合がよい。

【0073】マスク膜66については、シリコン構造層54をエッチングする際に選択比が高い材料であればよい。但し、シリコン酸化膜を用いた場合には、犠牲層51を除去する際に一緒に除去されるので都合がよい。

【0074】更にまた、上述のパッシベーション膜67は窒化シリコン膜で構成したが、それに限定されるものではない。但し、上述のように、マスク膜66をシリコン酸化膜で構成した場合には、犠牲層51の除去の際にパッシベーション膜が露出してしまうので、フッ酸緩衝溶液によってエッチングされない材料が望ましい。

【0075】なお、上記実施例はSOI基板の場合について説明したが、構造層がシリコン単結晶ではなく、ポリシリコンで構成されたウェハーを用いて製造されたものも本発明に含まれる。

【0076】

【発明の効果】本発明によれば、薄膜配線を構成する材料で電極を形成することができる。また、リフトオフ法を用いずにマイクロマシンを製造することができる。マスク膜を形成する前に電気素子、薄膜配線、又は電極を＊

12

＊形成しておくので、構造層をエッチングした後はフォトリソグラフ工程を行わなくても済む。

【図面の簡単な説明】

【図1】本発明の複合デバイスの一例を示す図

【図2】(a)～(e)：その製造工程の前半を説明するための図

【図3】(f)～(i)：その中半を説明するための図

【図4】(j)～(m)：その後半を説明するための図

【図5】従来技術のセンサーの斜視図

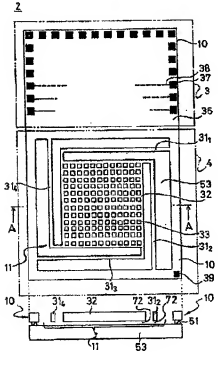
【図6】(a)～(e)：その製造工程の前半を説明するための図

【図7】(f)～(j)：その後半を説明するための図

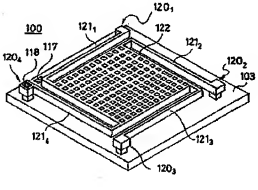
【符号の説明】

2……複合デバイス　3……回路部　4……マイクロマシン部　10……固定体　11……可動体　37……電極　38……薄膜配線　41……電気素子　50……ウェハー　51……犠牲層　53……基板　54……構造層　60……金属薄膜　64……保護膜　65……パッシベーション膜　66……マスク膜　80……導電性基体

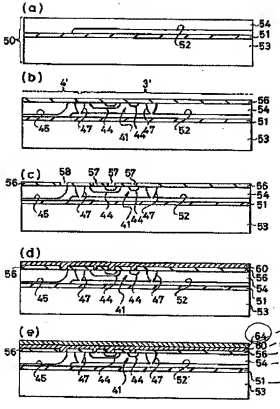
【図1】



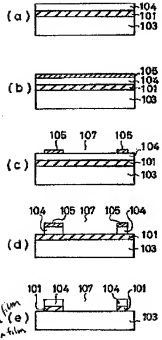
【図5】



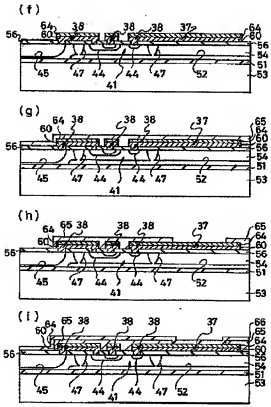
【図2】


(a)
50
54
51
52
53
(b)
4'
3'
56
54
51
45
47
44
41
44
47
52
53
(c)
58
57
57
57
56
55
54
51
45
47
44
41
44
47
52
53
(d)
56
60
55
54
51
45
47
44
44
47
52
41
53
(e)
64
60
56
54
56
45
47
44
44
47
52
41
51
53
Passivation film
Metallic thin film
structure layer
Sacrifice layer

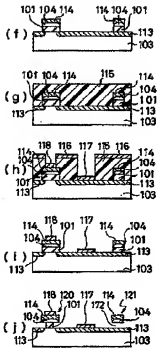
【図6】


(a)
104
101
103
(b)
105
104
101
103
(c)
105
107
105
104
101
103
(d)
104
105
107
105
104
101
103
(e)
101
104
107
104
101
103

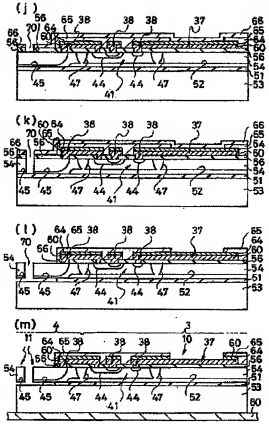
【図3】



【図7】



[図4]



NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1] The process which forms the mask film by which patterning was carried out on the structure layer formed on the substrate through the sacrifice layer, The process which uses the mask film for a mask, etches said structure layer, and exposes said sacrifice layer, It has the process which removes the sacrifice layer under [said] a structure layer from said exposed part by etching which exists side etching. A movable object is formed in the part which removed the sacrifice layer under a base completely among said structure layers. The process which constitutes an electric element in the structure layer which is the manufacture approach of the combinational device which forms a fixed object in the part which left the sacrifice layer under a base, and constitutes said fixed object before forming said mask film, The manufacture approach of the combinational device characterized by having the process which forms the metal thin film which contains the electrode for external connection at least on said structure layer, and the process which carries out patterning of this metal thin film.
[Claim 2] The manufacture approach of the combinational device according to claim 1 characterized by etching said electrode when forming the protective coat in said electrode surface and etching said sacrifice layer, before forming said mask film, after forming said metal thin film.
[Claim 3] The manufacture approach of the combinational device according to claim 2 characterized by forming the passivation film which carried out patterning on said protective coat before forming said mask film, after forming said protective coat.
[Claim 4] The manufacture approach of the combinational device according to claim 3 which uses as a mask said passivation film which carried out patterning, and is characterized by removing said protective coat on said electrode.
[Claim 5] The manufacture approach of the combinational device of claim 1 characterized by forming metal wiring which connects said electric element of each other with the metal thin film in case patterning of said metal thin film is carried out thru/or claim 4 given in any 1 term.
[Claim 6] The manufacture approach of the combinational device of claim 1 characterized by fixing said substrate on a conductive base and enabling it to perform electrical installation from the rear face of said substrate to said conductive base thru/or claim 5 given in any 1 term.
[Claim 7] It is the manufacture approach of the combinational device of claim 1 which said structure layer and said substrate are a silicon substrate, and is characterized by said sacrifice layer being silicon oxide thru/or claim 6 given in any 1 term.
[Claim 8] Said passivation film is the manufacture approach of the combinational device of claim 4 characterized by being a silicon nitride film thru/or claim 7 given in any 1 term.
[Claim 9] After patterning of said structure layer of the wafer with which a sacrifice layer is located between a substrate and a structure layer was carried out, Said sacrifice layer is etched and a movable object is formed in the part from which the sacrifice layer under a base was completely removed among said structure layers. Although it is the combinational device in which the fixed object was formed in the part to which the sacrifice layer under a base was left behind, and the electrode for thin film wiring and external connection is prepared and a protective coat is formed on said metal thin film with the metal

thin film which was formed on said structure layer and by which patterning was carried out The combinational device characterized by removing said protective coat on said electrode at least after etching of said sacrifice layer.

[Claim 10] The combinational device according to claim 9 characterized by preparing an electric element into the structure layer which constitutes said fixed object, and said thin film wiring connecting electrically mutually.

[Claim 11] The combinational device of claim 9 which has a conductive base, and said substrate is the combinational device fixed to said conductive base, and is characterized by being constituted so that electrical installation from the rear face of said substrate to said conductive base can be performed, or claim 10 given in any 1 term.

[Translation done.]

* NOTICES *

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention starts a combinational device and its manufacture approach, and the metal thin film in a circuit element is related with the combinational device protected by the protective coat, and its manufacture approach in the combinational device especially equipped with the micro machine and the circuit element in the case of etching of the sacrifice layer when forming the micro machine.
[0002]
[Description of the Prior Art] In recent years, the silicon micromachining technology is used widely, for example, it is applied to an acceleration sensor or an angular-velocity sensor, and the detailed sensor component is created on the silicon semi-conductor substrate.
[0003] As an example of such a silicon micro machine, an acceleration sensor is shown in the sign 100 of drawing 5 .
[0004] This acceleration sensor 100 has the mass section 122 formed on the silicon substrate 103, arms 1211-1214, and the fixed objects 1201-1204. The mass section 122 is fabricated by the rectangle configuration, the end of arms 1211-1214 is connected to the four corners, and the other end of each arms 1211-1214 is connected to each fixed objects 1201-1204.
[0005] The fixed objects 1201-1204 are fixed on a silicon substrate 103. Another side, the mass section 122, and arms 1211-1214 When the movable configuration is carried out so that a substrate 103 may not be contacted, an acceleration sensor 100 carries out acceleration migration in the vertical direction and the force joins the mass section 122 Arms 1211-1214 bend up and down by using the fixed objects 1201-1204 as the supporting point, and it is constituted so that the capacity of the parallel plate capacitor which consists of the mass section 122 and a substrate 103 may change.
[0006] The production process of such an acceleration sensor 100 is simplified and shown in drawing 6 (a) - (e) and drawing 7 (f) - (j), and it explains below.
[0007] Drawing 6 (a) With reference to - (e), two silicon single crystal substrates with which silicon oxide was formed in the front face are prepared first, and the silicon oxide is stuck, it joins with a direct conjugation method, and the silicon wafer of one sheet is formed. Subsequently, the field of a side and the opposite side in which the thermal oxidation film of one silicon single crystal was formed is ground, and it considers as the structure layer 104, and the silicon single crystal layer of another side is left as it is, and let it be a substrate 103. Between the substrate 103 and structure layer 104, the silicon oxide used for direct junction is left behind as a sacrifice layer 101 (drawing 9 (a)).
[0008] An oxide film 105 is completely formed on structure layer 104 front face of such a silicon wafer (this drawing (b)), by etching a predetermined field, patterning is carried out and opening 107 is formed (this drawing (c)).
[0009] By silicon structure layer 104 front face being exposed to this opening 107 base, using as a mask the oxide film 105 which it left, without etching, and performing anisotropy dry etching by the RIE method, etching removal of the structure layer 104 exposed to said opening 107 base is carried out, and

patterning is carried out to the same pattern as the pattern of the oxide film 105 with which the structure layer 104 remained (this drawing (d)).
[0010] If the sacrifice layer 101 is exposed to opening 107 base and wet etching is performed when the patterning is completed, the sacrifice layer 101 exposed to oxide-film 105 and opening 107 base used for patterning of the structure layer 104 will be removed (this drawing (e)).
[0011] In the condition, if ion implantation and thermal diffusion are performed, the ohmic layers 113 and 114 will be formed in the part exposed to the front face of a substrate 103 and the structure layer 104, respectively (drawing 10 (f)).
[0012] Subsequently, if vacuum evaporationo of chromium and platinum is performed after forming the resist film 115 in the whole surface (this drawing (g)) and carrying out window opening of the ohmic layer 113 and the predetermined part on 114, chromium and the platinum thin films 116, 117, and 118 will be formed on the ohmic layer 113 and 114 the resist film 115 top, respectively (this drawing (h)).
[0013] If the resist film 115 is exfoliated from this condition, the chromium and the platinum thin film 116 formed on the resist film 115 will be removed together with the resist film 115 (the lift-off method). On the other hand, the ohmic layer 113, and the chromium and the platinum thin films 117 and 118 which were formed on 114 remain without being removed, and a metal electrode is formed in a substrate 103 and the fixed object 1204, respectively (this drawing (i)).
[0014] Furthermore, if immersed in the fluoric acid buffer solution (BHF), since the side face of the sacrifice layer 101 will have exposed the whole, the sacrifice layer 101 is etched from the side face. At this time, area is large among the structure layers 104, or the sacrifice layer 101 under that base is left behind in a part with wide width of face. Therefore, the structure layer 104 of the part is being fixed to the substrate 103 by the sacrifice layer 101, and the fixed objects 1201-1204 are constituted.
[0015] On the other hand, area will be small among the structure layers 104, or the sacrifice layer 101 under a base will be completely removed in a part with narrow width of face. Therefore, if the structure layer 54 of the part is connected with the structure layer which constitutes a fixed object, space 72 is formed between substrates 103 and a substrate 103 and a non-contact movable object are constituted. Arms 1211-1214 and the mass section 122 are constituted by such movable object.
[0016] Thus, the mass section 122 and arms 1211-1214 are supported with the fixed objects 1201-1204 in the condition of not contacting a substrate 103, when acceleration is added, arms 1211-1224 bend with the weight of the mass section 122, and the distance between a substrate 103 and the mass section 122 changes.
[0017] Therefore, wire-bonding connection of the metal thin line is made at electrodes 117 and 118, and if it connects with the measuring circuit of the exterior which does not illustrate the mass section 122 and a substrate 103, the capacity change between the mass section 122 and a substrate 103 will be detected, and it becomes possible to compute the magnitude of acceleration.
[0018] However, as mentioned above, with the conventional technique, in order to use the lift-off method for formation of chromium and the platinum thin film 116, the process was complicated, and moreover, in order to use the lift-off method, with the aluminum thin film which constitutes thin film wiring in an integrated circuit, electrodes 117 and 118 could not be formed but it had become a failure at the time of forming a circuit element and a micro machine on the same substrate.
[0019]
[Problem(s) to be Solved by the Invention] It was not created in order that this invention might solve un-arranging [of the above-mentioned conventional technique], and the purpose is in offering the technique which can form the electrode of a combinational device, without using the lift-off method.
[0020]
[Means for Solving the Problem] In order to solve the above-mentioned technical problem, the invention approach according to claim 1 The process which forms the mask film by which patterning was carried out on the structure layer formed on the substrate through the sacrifice layer, The process which uses the mask film for a mask, etches said structure layer, and exposes said sacrifice layer, It has the process which removes the sacrifice layer under [said] a structure layer from said exposed part by etching which exists side etching. A movable object is formed in the part which removed the sacrifice layer

under a base completely among said structure layers. The process which constitutes an electric element in the structure layer which is the manufacture approach of the combinational device which forms a fixed object in the part which left the sacrifice layer under a base, and constitutes said fixed object before forming said mask film, It is characterized by having the process which forms the metal thin film which contains the electrode for external connection at least on said structure layer, and the process which carries out patterning of this metal thin film.

[0021] In this case, after forming said metal thin film, before forming said mask film like the invention approach according to claim 2, in case the protective coat is formed in said electrode surface and said sacrifice layer is etched, it is good for said electrode to be made not to be etched.

[0022] By the manufacture approach of the combinational device according to claim 2, after forming said protective coat, before forming said mask film like the invention approach according to claim 3, the passivation film which carried out patterning can be formed on said protective coat.

[0023] Furthermore, it is good to use as a mask said passivation film which carried out patterning like the invention approach according to claim 4, and to remove said protective coat on said electrode by the manufacture approach of the combinational device according to claim 3.

[0024] It is good to form metal wiring which connects said electric element of each other with the metal thin film by such manufacture approach of the combinational device of claim 1 thru/or claim 4 given in any 1 term, in case patterning of said metal thin film is carried out like the invention approach according to claim 5.

[0025] Moreover, it is good to fix said substrate on a conductive base like invention according to claim 6, and to enable it to perform electrical installation from the rear face of said substrate to said conductive base by the manufacture approach of the combinational device of claim 1 thru/or claim 5 given in any 1 term.

[0026] It is convenient further again in said structure layer and said substrate being a silicon substrate, and said sacrifice layer being silicon oxide like the invention approach according to claim 7, by the manufacture approach of the combinational device of claim 1 thru/or claim 6 given in any 1 term.

[0027] In addition, about the manufacture approach of the combinational device of claim 4 thru/or claim 7 given in any 1 term, said passivation film is convenient in it being a silicon nitride film like the invention approach according to claim 8.

[0028] On the other hand, the wafer with which, as for invention equipment according to claim 9, a sacrifice layer is located between a substrate and a structure layer, After patterning of said structure layer is carried out, said sacrifice layer is etched. A movable object is formed in the part from which the sacrifice layer under a base was completely removed among said structure layers. Although it is the combinational device in which the fixed object was formed in the part to which the sacrifice layer under a base was left behind, and thin film wiring and the electrode for external connection are prepared and a protective coat is formed on said metal thin film with the metal thin film which was formed on said structure layer and by which patterning was carried out It is characterized by removing said protective coat on said electrode at least after etching of said sacrifice layer.

[0029] In this combinational device according to claim 9, it is good like invention equipment according to claim 10 to prepare an electric element into the structure layer which constitutes said fixed object, and to connect electrically mutually with said thin film wiring.

[0030] Moreover, it is convenient, when the combinational device of claim 9 or claim 10 given in any 1 term has a conductive base, and said substrate is being fixed to said conductive base, and it constitutes like invention equipment according to claim 11 so that electrical installation from the rear face of said substrate to said conductive base can be performed.

[0031] According to the configuration of this invention mentioned above, the mask film is formed on the structure layer formed on the substrate through the sacrifice layer. Use the mask film for a mask, etch a structure layer, and a sacrifice layer is exposed. Since a movable object is made to form in the part which removed the sacrifice layer under a structure layer base from the exposed part by side etching, and removed the sacrifice layer under a base completely among structure layers and a fixed object is made to form in the part which left the sacrifice layer under a base Although a micro machine can be

made to constitute from a movable object and a fixed object Since a circuit can be constituted if an electric element is made to constitute, the metal thin film which contains the electrode for external connection at least on a structure layer is formed into the structure layer which constitutes a fixed object and patterning of the metal thin film is carried out before forming the above-mentioned mask film Even if it does not use the lift-off method, a micro machine and a circuit can be made to form into the same substrate.

[0032] If the electrode is made not to be etched in case the protective coat is formed in the electrode surface and a sacrifice layer is etched before forming the mask film after forming a metal thin film in that case, it is lost that the electrode surface for electrical installation with the exterior is damaged, and a quality electrode can be formed.

[0033] Moreover, before forming the mask film after forming a protective coat, when the passivation film which carried out patterning is formed on the protective coat, it improves and is desirable [the dependability of a combinational device]. As for the passivation film, what is not etched in case a sacrifice layer is removed is good, and it can remove a protective coat in that case by using as a mask the passivation film by which patterning was carried out.

[0034] If metal wiring which connects the electric element of each other with the metal thin film is formed further again in case patterning of the metal thin film is carried out, patterning of a structure layer and everything but removal of a sacrifice layer can manufacture a combinational device at the process of the usual integrated-circuit manufacture.

[0035] Moreover, even if it will not form an electrode in a substrate front face if it enables it to perform electrical installation with the conductive base from the rear face of a substrate in case a substrate is fixed to conductive bases, such as a leadframe, it becomes possible to perform electrical installation of the capacitor which consists of a movable object and a substrate.

[0036] In addition, if an above-mentioned structure layer and an above-mentioned substrate consist of silicon substrates and a sacrifice layer consists of silicon oxide, manufacture is easy, and cost will be low and will end. Moreover, manufacture will become easy if PASSHIBESHOMMAKU is used as the silicon nitride film.

[0037]

[Embodiment of the Invention] The gestalt of operation of this invention is explained using a drawing. The top view and its A-A line sectional view of a combinational device 2 of this invention are shown in drawing 1 . [of an example]

[0038] This combinational device 2 has the substrate 53 which is a silicon semi-conductor, and the circuit section 3 and the micro machine section 4 are formed on that substrate 53.

[0039] The micro machine sections 4 are the sensor 100 shown in drawing 5 , and the acceleration sensor of the same structure, and have the movable movable object 11 and the fixed fixed object 10 to the substrate 53.

[0040] This acceleration sensor has the arms 311-314 with narrow width of face, and the mass section 32 in which the stoma 33 was formed in the shape of a matrix by the large area, the end of arms 311-314 is connected to the fixed object 10, and it connects with the mass section 32 which consisted of movable objects 11, and the other end is constituted so that the mass section 32 may be supported with each arms 311-314 and the fixed object 10.

[0041] If the opening 72 is formed in the base of arms 311-314, and the base of the mass section 32, therefore the mass section 32 and a substrate 53 are in a non-contact condition and acceleration is added, each arms 311-314 bend with the weight of the mass section 32, and it is constituted so that the mass section 32 can move in the vertical direction.

[0042] Therefore, if the mass section 32 carries out vertical migration of the capacitor of an parallel monotonous mold which arms 311-314 and the mass section 32 are constituted by the movable object 11, and is constituted by the mass section 32 and the substrate 53, he is trying for capacity value to change.

[0043] On the other hand, the circuit section 3 has the electric element of a large number formed into the structure layer which constitutes the fixed object 36, and the measuring circuit is formed of those

electric elements.
[0044] Moreover, the electrode pad 37 which is an electrode for external connection of a large number formed of patterning of a metal thin film in the circuit section 3, The thin film wiring 38 which performs electrical installation between electric elements and electrical installation between an electric element and the electrode pad 37 is formed. It connects with the above-mentioned measuring circuit through the thin film wiring 38, and the mass section 32 is constituted so that capacity change of the capacitor in which the measuring circuit is formed with the mass section 32 and a substrate 53 can be detected.
[0045] The structure of such a combinational device 2 is explained with the manufacture approach with reference to drawing 2 (a) - (e) drawing 3 (f) - (i) and drawing 4 (j) - (m). In addition, in the cross-section structure, a part of each important section of circuit section 3' shown in drawing 1 and micro machine section 4' is shown.
[0046] First, two silicon single crystal wafers with which silicon oxide was formed in the front face are prepared. In one silicon single crystal wafer, the diffusion layer 52 of a conductivity type opposite to the wafer is formed in the predetermined field, and silicon oxide is formed in the near front face in which the diffusion layer 52 is formed.
[0047] The silicon oxide of such two silicon single crystal wafers is stuck, and one wafer 50 is formed with a direct conjugation method.
[0048] Then, the silicon single crystal layer of the direction in which the diffusion layer 52 was formed is ground, and it is made thin to predetermined thickness, and considers as the surface structure layer 54. Another side makes a substrate 53 constitute from a condition as it is. Moreover, the silicon oxide used on the occasion of direct junction is taken as the sacrifice layer 51.
[0049] The usual semi-conductor process of using for integrated-circuit manufacture is applied to this wafer 50, and the electronic-circuitry elements containing a bipolar transistor are formed. If the part is shown all over drawing, after forming the thin silicon thermal oxidation film 56 on the structure layer 56, into the structure layer 54 (field shown by sign 3') used as the circuit section, two or more diffusion layers 44 will be established (a diffusion layer 44 also contains the thing of a different conductivity type), and many electric elements 41 will be formed (this drawing (b)).
[0050] The depth comparable as the thickness of the structure layer 54 is made to diffuse the diffusion layer 45 of the same conductivity type as the structure layer 54 in the structure layer 54 (field shown by sign 4') used as the micro machine section at this time. Moreover, a detached core 47 is formed into the structure layer 54 used as the circuit section, and each electric element 41 is made to separate electrically with a diffusion layer 52.
[0051] In the condition, the insulator layer 56 which consists of silicon oxide is formed in structure layer 54 front face, patterning of the insulator layer 56 is carried out, and openings 57 and 58 are formed in the predetermined location on the structure layer 54 which serves as the micro machine section an electric element 41 top, respectively (this drawing (c)).
[0052] In the condition, by the sputtering method, the metal thin film 60 which consists of an aluminum thin film is formed completely (this drawing (d)), and the protective coat 64 which changes from a titanium tungsten thin film to the front face of the metal thin film 60 is continued, and membranes are formed completely (this drawing (e)).
[0053] Next, patterning of a protective coat 64 and the metal thin film 60 is carried out together, and area forms the electrode pad 37 of a large rectangle configuration, and the thin film wiring 38 with narrow width of face. At this time, the protective coat 64 and the metal thin film 60 on the structure layer 54 used as the movable object 11 are removed.
[0054] If the thin film wiring 38 is electrically connected to a diffusion layer 45 or a diffusion layer 44 through openings 57 and 58, between electric element 41 comrades and between an electric element 41 and the electrode pads 37 will be electrically connected by the thin film wiring 38. Moreover, the movable object 11 of the micro machine section can be electrically connected to an electric element 41 or the electrode pad 37 with the thin film wiring 38 (drawing 3 (f)).
[0055] If the passivation film 67 which consists of a silicon nitride is deposited on a front face (this drawing (g)) and the passivation film 67 on the micro machine section and the electrode pad 37 is

subsequently removed from the condition, on the micro machine section, an insulator layer 56 will be exposed, and a protective coat 64 will be exposed on the electrode pad 37 (this drawing (h)).
[0056] If the mask film 66 which consists of silicon oxide is made to deposit on the front face, on the structure layer 54 of micro machine circles, the mask film 66 will be formed on the insulator layer 56 which similarly consists of silicon oxide. Moreover, on the electrode pad 37 of circuit circles, the mask film 66 is formed on the protective coat 64 which consists of a titanium tungsten thin film, and is formed in another side and other parts of circuit circles on the passivation film 65 which consists of a silicon nitride film (this drawing (i)).
[0057] Next, if patterning of the mask film 66 and an insulator layer 56 is performed together and opening 70 is formed in micro machine circles, silicon structure layer 54 front face (diffusion layer 45) will be exposed to the opening 70 base (this drawing (j)).
[0058] If the mask film 66 is located, the front face of fields other than opening 70 uses the mask film 66 for a mask and anisotropic etching is performed, the structure layer 54 exposed to opening 70 base will be etched. The anisotropic etching stops in the place which sacrifice layer 51 front face exposed to the base of opening 70 (this drawing (k)). The structure layer 54 which constitutes arms 311-314 and the mass section 32 is fabricated by etching of the structure layer 54 from such opening 70.
[0059] Subsequently, if the whole is immersed in the fluoric acid buffer solution (BHF), etching of the sacrifice layer 51 will be started from the base of opening 70. The etching advances also in the longitudinal direction of the sacrifice layer 51 (side etching), and the sacrifice layer 51 in the base of the structure layer 54 is corroded from a side face.
[0060] this time -- the facet among the structure layers 54 -- in a product or the part formed in narrow, although the sacrifice layer 51 under that base is removed completely, in a large area or the part formed broadly, the sacrifice layer 51 remains in the bottom of the base of the structure layer 54, and the structure layer 54 of that part is fixed to a substrate 53 by the sacrifice layer 51. The fixed object 10 is constituted by such a large area or the structure layer 54 formed broadly, and the sacrifice layer 51 of the base.
[0061] When small area or the structure layer 54 formed in narrow is connected to the structure layer 54 which constitutes the fixed object 10, an opening 72 is formed between the structure layer 54 and a substrate 53, and the movable object 11 is constituted from a place where the sacrifice layer 51 under a base was removed by the structure layer 54 of the part (this drawing (l)).
[0062] The structure layer 54 of the above-mentioned arms 311-314 has narrow width of face, since the end is connected to the structure layer 54 which constitutes the fixed object 10, the sacrifice layer 51 is removed and arms 311-314 are constituted by the movable object 11.
[0063] Since the other end of arms 311-314 is connected to the four corners of the mass section 32, the opening 70 which becomes the structure layer 54 of the mass section 32 with a stoma 33 is arranged in the shape of a matrix, width of face of structure layer 54 the very thing is narrowed and the sacrifice layer 51 under a base is removed as mentioned above, the mass section 32 is constituted by the movable object 11.
[0064] Thus, since the mask film 66 which consisted of silicon oxide as well as the sacrifice layer 51 is also removed together in case the fixed object 10 and the movable object 11 are formed by etching of the sacrifice layer 51, on the thin film wiring 38 of the circuit section, the passivation film 65 is exposed to a front face, and a protective coat 64 is exposed on the electrode pad 37. In the micro machine section, although an insulator layer 56 is exposed with removal of the mask film 66, since the insulator layer 56 consists of silicon oxide, an insulator layer 56 will also be removed and the front face (diffusion layer 45) of the structure layer 54 exposes it.
[0065] After etching the sacrifice layer 51, the protective coat 64 which exposed the whole to electrode pad 37 front face when immersed in hydrogen peroxide solution is removed, and the metal thin film 60 is exposed to a front face (this drawing (m)).
[0066] Then, if a substrate 80 is fixed on the conductive bases 80, such as a leadframe, in the condition of having electrical installation with the rear face of a substrate 53 and a lead and the electrode pad 37 of the conductive base 80 are connected by wire bonding, the combinational device 2 by which the

capacitor which consists of a substrate 53 and the mass section 32 was connected to the measuring circuit in the circuit section 3 formed on the same substrate 53 can be obtained.
[0067] In this case, wire bonding may not be carried out for the conductive base 80 and the electrode pad 37, but wire bonding of the lead etc. may be carried out to the conductive base 80.
[0068] Although the above-mentioned thin film wiring 38 was formed in the circuit section 3, as the sign 39 of drawing 1 shows, you may form in the micro machine section 4. It is made to connect with a diffusion layer 45 electrically through the thin film wiring 38, or direct continuation may be carried out to a diffusion layer 45, and you may connect with the mass section 32 electrically, and with the thin film wiring 38, it may connect with the measuring circuit in the circuit section 3, and the electrode 39 in the micro machine section 4 may be used as the electrode.
[0069] Although the above made the electric element 41 separate by pn junction, what is depended on the various separation approaches, such as dielectric separation, is contained in this invention. Moreover, as for the electric element 41 formed in the circuit section 3, electric elements, such as a bipolar transistor, an MOS transistor, a resistance element, and a capacitor, are contained widely.
[0070] Moreover, although the above explained the combinational device of the acceleration sensor which detects capacity change of the capacitor formed between a movable object and a substrate, this invention is not limited to it. For example, the combinational device which measures capacity change of the capacitor formed between a movable object and a fixed object, and the combinational device which, in addition to this, has micro machines other than a sensor are included widely.
[0071] Although the above-mentioned example connected the structure layer 54 and electric element 41 of the movable object 11 through the thin film wiring 38, it may be connected according to the diffusion layer in the structure layer 54.
[0072] Although silicon oxide was used for the mask film 66 at the above-mentioned protective coat 64 using the titanium tungsten thin film, it is not limited to it. In case a protective coat 64 removes the sacrifice layer 51, it should just be a thin film which is not removed with the etching solution (this example fluoric acid buffer solution), but when a titanium tungsten thin film is used as a protective coat 64, since the hydrogen peroxide solution which is the etching solution does not etch the usual passivation film, such as a silicon nitride, it is convenient.
[0073] A selection ratio should just be a high ingredient in case the silicon structure layer 54 is etched about the mask film 66. However, when silicon oxide is used, since it is removed together in case the sacrifice layer 51 is removed, it is convenient.
[0074] Furthermore, although the above-mentioned passivation film 67 was constituted from a silicon nitride film, it is not limited to it again. However, since the passivation film is exposed as mentioned above in the case of removal of the sacrifice layer 51 when the mask film 66 is constituted from silicon oxide, the ingredient which is not etched with fluoric acid buffer solution is desirable.
[0075] In addition, although the above-mentioned example explained the case of a SOI substrate, that by which the structure layer was manufactured not using a silicon single crystal but using the wafer which consisted of polish recons is also contained in this invention.
[0076]
[Effect of the Invention] According to this invention, an electrode can be formed with the ingredient which constitutes thin film wiring. Moreover, a micro machine can be manufactured, without using the lift-off method. Since an electric element, thin film wiring, or an electrode is formed before forming the mask film, it can be managed, even if it does not perform a photograph RISOGURAFU process after etching a structure layer.

[Translation done.]

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TECHNICAL FIELD

[Field of the Invention] This invention starts a combinational device and its manufacture approach, and the metal thin film in a circuit element is related with the combinational device protected by the protective coat, and its manufacture approach in the combinational device especially equipped with the micro machine and the circuit element in the case of etching of the sacrifice layer when forming the micro machine.

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PRIOR ART

[Description of the Prior Art] In recent years, the silicon micromachining technology is used widely, for example, it is applied to an acceleration sensor or an angular-velocity sensor, and the detailed sensor component is created on the silicon semi-conductor substrate.
[0003] As an example of such a silicon micro machine, an acceleration sensor is shown in the sign 100 of drawing 5 .
[0004] This acceleration sensor 100 has the mass section 122 formed on the silicon substrate 103, arms 1211-1214, and the fixed objects 1201-1204. The mass section 122 is fabricated by the rectangle configuration, the end of arms 1211-1214 is connected to the four corners, and the other end of each arms 1211-1214 is connected to each fixed objects 1201-1204.
[0005] The fixed objects 1201-1204 are fixed on a silicon substrate 103. Another side, the mass section 122, and arms 1211-1214 When the movable configuration is carried out so that a substrate 103 may not be contacted, an acceleration sensor 100 carries out acceleration migration in the vertical direction and the force joins the mass section 122 Arms 1211-1214 bend up and down by using the fixed objects 1201-1204 as the supporting point, and it is constituted so that the capacity of the parallel plate capacitor which consists of the mass section 122 and a substrate 103 may change.
[0006] The production process of such an acceleration sensor 100 is simplified and shown in drawing 6 (a) - (e) and drawing 7 (f) - (j), and it explains below.
[0007] Drawing 6 (a) With reference to - (e), two silicon single crystal substrates with which silicon oxide was formed in the front face are prepared first, and the silicon oxide is stuck, it joins with a direct conjugation method, and the silicon wafer of one sheet is formed. Subsequently, the field of a side and the opposite side in which the thermal oxidation film of one silicon single crystal was formed is ground, and it considers as the structure layer 104, and the silicon single crystal layer of another side is left as it is, and let it be a substrate 103. Between the substrate 103 and structure layer 104, the silicon oxide used for direct junction is left behind as a sacrifice layer 101 (drawing 9 (a)).
[0008] An oxide film 105 is completely formed on structure layer 104 front face of such a silicon wafer (this drawing (b)), by etching a predetermined field, patterning is carried out and opening 107 is formed (this drawing (c)).
[0009] By silicon structure layer 104 front face being exposed to this opening 107 base, using as a mask the oxide film 105 which it left, without etching, and performing anisotropy dry etching by the RIE method, etching removal of the structure layer 104 exposed to said opening 107 base is carried out, and patterning is carried out to the same pattern as the pattern of the oxide film 105 with which the structure layer 104 remained (this drawing (d)).
[0010] If the sacrifice layer 101 is exposed to opening 107 base and wet etching is performed when the patterning is completed, the sacrifice layer 101 exposed to oxide-film 105 and opening 107 base used for patterning of the structure layer 104 will be removed (this drawing (e)).
[0011] In the condition, if ion implantation and thermal diffusion are performed, the ohmic layers 113 and 114 will be formed in the part exposed to the front face of a substrate 103 and the structure layer 104, respectively (drawing 10 (f)).

[0012] Subsequently, if vacuum evaporationo of chromium and platinum is performed after forming the resist film 115 in the whole surface (this drawing (g)) and carrying out window opening of the ohmic layer 113 and the predetermined part on 114, chromium and the platinum thin films 116, 117, and 118 will be formed on the ohmic layer 113 and 114 the resist film 115 top, respectively (this drawing (h)).
[0013] If the resist film 115 is exfoliated from this condition, the chromium and the platinum thin film 116 formed on the resist film 115 will be removed together with the resist film 115 (the lift-off method). On the other hand, the ohmic layer 113, and the chromium and the platinum thin films 117 and 118 which were formed on 114 remain without being removed, and a metal electrode is formed in a substrate 103 and the fixed object 1204, respectively (this drawing (i)).
[0014] Furthermore, if immersed in the fluoric acid buffer solution (BHF), since the side face of the sacrifice layer 101 will have exposed the whole, the sacrifice layer 101 is etched from the side face. At this time, area is large among the structure layers 104, or the sacrifice layer 101 under that base is left behind in a part with wide width of face. Therefore, the structure layer 104 of the part is being fixed to the substrate 103 by the sacrifice layer 101, and the fixed objects 1201-1204 are constituted.
[0015] On the other hand, area will be small among the structure layers 104, or the sacrifice layer 101 under a base will be completely removed in a part with narrow width of face. Therefore, if the structure layer 54 of the part is connected with the structure layer which constitutes a fixed object, space 72 is formed between substrates 103 and a substrate 103 and a non-contact movable object are constituted. Arms 1211-1214 and the mass section 122 are constituted by such movable object.
[0016] Thus, the mass section 122 and arms 1211-1214 are supported with the fixed objects 1201-1204 in the condition of not contacting a substrate 103, when acceleration is added, arms 1211-1224 bend with the weight of the mass section 122, and the distance between a substrate 103 and the mass section 122 changes.
[0017] Therefore, wire-bonding connection of the metal thin line is made at electrodes 117 and 118, and if it connects with the measuring circuit of the exterior which does not illustrate the mass section 122 and a substrate 103, the capacity change between the mass section 122 and a substrate 103 will be detected, and it becomes possible to compute the magnitude of acceleration.
[0018] However, as mentioned above, with the conventional technique, in order to use the lift-off method for formation of chromium and the platinum thin film 116, the process was complicated, and moreover, in order to use the lift-off method, with the aluminum thin film which constitutes thin film wiring in an integrated circuit, electrodes 117 and 118 could not be formed but it had become a failure at the time of forming a circuit element and a micro machine on the same substrate.

[Translation done.]

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EFFECT OF THE INVENTION

[Effect of the Invention] According to this invention, an electrode can be formed with the ingredient which constitutes thin film wiring. Moreover, a micro machine can be manufactured, without using the lift-off method. Since an electric element, thin film wiring, or an electrode is formed before forming the mask film, it can be managed, even if it does not perform a photograph RISOGURAFU process after etching a structure layer.

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TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] It was not created in order that this invention might solve un-arranging [of the above-mentioned conventional technique], and the purpose is in offering the technique which can form the electrode of a combinational device, without using the lift-off method.

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MEANS

[Means for Solving the Problem] In order to solve the above-mentioned technical problem, the invention approach according to claim 1 The process which forms the mask film by which patterning was carried out on the structure layer formed on the substrate through the sacrifice layer, The process which uses the mask film for a mask, etches said structure layer, and exposes said sacrifice layer, It has the process which removes the sacrifice layer under [said] a structure layer from said exposed part by etching which exists side etching. A movable object is formed in the part which removed the sacrifice layer under a base completely among said structure layers. The process which constitutes an electric element in the structure layer which is the manufacture approach of the combinational device which forms a fixed object in the part which left the sacrifice layer under a base, and constitutes said fixed object before forming said mask film, It is characterized by having the process which forms the metal thin film which contains the electrode for external connection at least on said structure layer, and the process which carries out patterning of this metal thin film.
[0021] In this case, after forming said metal thin film, before forming said mask film like the invention approach according to claim 2, in case the protective coat is formed in said electrode surface and said sacrifice layer is etched, it is good for said electrode to be made not to be etched.
[0022] By the manufacture approach of the combinational device according to claim 2, after forming said protective coat, before forming said mask film like the invention approach according to claim 3, the passivation film which carried out patterning can be formed on said protective coat.
[0023] Furthermore, it is good to use as a mask said passivation film which carried out patterning like the invention approach according to claim 4, and to remove said protective coat on said electrode by the manufacture approach of the combinational device according to claim 3.
[0024] It is good to form metal wiring which connects said electric element of each other with the metal thin film by such manufacture approach of the combinational device of claim 1 thru/or claim 4 given in any 1 term, in case patterning of said metal thin film is carried out like the invention approach according to claim 5.
[0025] Moreover, it is good to fix said substrate on a conductive base like invention according to claim 6, and to enable it to perform electrical installation from the rear face of said substrate to said conductive base by the manufacture approach of the combinational device of claim 1 thru/or claim 5 given in any 1 term.
[0026] It is convenient further again in said structure layer and said substrate being a silicon substrate, and said sacrifice layer being silicon oxide like the invention approach according to claim 7, by the manufacture approach of the combinational device of claim 1 thru/or claim 6 given in any 1 term.
[0027] In addition, about the manufacture approach of the combinational device of claim 4 thru/or claim 7 given in any 1 term, said passivation film is convenient in it being a silicon nitride film like the invention approach according to claim 8.
[0028] On the other hand, the wafer with which, as for invention equipment according to claim 9, a sacrifice layer is located between a substrate and a structure layer, After patterning of said structure layer is carried out, said sacrifice layer is etched. A movable object is formed in the part from which the

sacrifice layer under a base was completely removed among said structure layers. Although it is the combinational device in which the fixed object was formed in the part to which the sacrifice layer under a base was left behind, and thin film wiring and the electrode for external connection are prepared and a protective coat is formed on said metal thin film with the metal thin film which was formed on said structure layer and by which patterning was carried out It is characterized by removing said protective coat on said electrode at least after etching of said sacrifice layer.
[0029] In this combinational device according to claim 9, it is good like invention equipment according to claim 10 to prepare an electric element into the structure layer which constitutes said fixed object, and to connect electrically mutually with said thin film wiring.
[0030] Moreover, it is convenient, when the combinational device of claim 9 or claim 10 given in any 1 term has a conductive base, and said substrate is being fixed to said conductive base, and it constitutes like invention equipment according to claim 11 so that electrical installation from the rear face of said substrate to said conductive base can be performed.
[0031] According to the configuration of this invention mentioned above, the mask film is formed on the structure layer formed on the substrate through the sacrifice layer. Use the mask film for a mask, etch a structure layer, and a sacrifice layer is exposed. Since a movable object is made to form in the part which removed the sacrifice layer under a structure layer base from the exposed part by side etching, and removed the sacrifice layer under a base completely among structure layers and a fixed object is made to form in the part which left the sacrifice layer under a base Although a micro machine can be made to constitute from a movable object and a fixed object Since a circuit can be constituted if an electric element is made to constitute, the metal thin film which contains the electrode for external connection at least on a structure layer is formed into the structure layer which constitutes a fixed object and patterning of the metal thin film is carried out before forming the above-mentioned mask film Even if it does not use the lift-off method, a micro machine and a circuit can be made to form into the same substrate.
[0032] If the electrode is made not to be etched in case the protective coat is formed in the electrode surface and a sacrifice layer is etched before forming the mask film after forming a metal thin film in that case, it is lost that the electrode surface for electrical installation with the exterior is damaged, and a quality electrode can be formed.
[0033] Moreover, before forming the mask film after forming a protective coat, when the passivation film which carried out patterning is formed on the protective coat, it improves and is desirable [the dependability of a combinational device]. As for the passivation film, what is not etched in case a sacrifice layer is removed is good, and it can remove a protective coat in that case by using as a mask the passivation film by which patterning was carried out.
[0034] If metal wiring which connects the electric element of each other with the metal thin film is formed further again in case patterning of the metal thin film is carried out, patterning of a structure layer and everything but removal of a sacrifice layer can manufacture a combinational device at the process of the usual integrated-circuit manufacture.
[0035] Moreover, even if it will not form an electrode in a substrate front face if it enables it to perform electrical installation with the conductive base from the rear face of a substrate in case a substrate is fixed to conductive bases, such as a leadframe, it becomes possible to perform electrical installation of the capacitor which consists of a movable object and a substrate.
[0036] In addition, if an above-mentioned structure layer and an above-mentioned substrate consist of silicon substrates and a sacrifice layer consists of silicon oxide, manufacture is easy, and cost will be low and will end. Moreover, manufacture will become easy if PASSHIBESHOMMAKU is used as the silicon nitride film.
[0037]
[Embodiment of the Invention] The gestalt of operation of this invention is explained using a drawing. The top view and its A-A line sectional view of a combinational device 2 of this invention are shown in drawing 1 . [of an example]
[0038] This combinational device 2 has the substrate 53 which is a silicon semi-conductor, and the

circuit section 3 and the micro machine section 4 are formed on that substrate 53.
[0039] The micro machine sections 4 are the sensor 100 shown in drawing 5 , and the acceleration sensor of the same structure, and have the movable movable object 11 and the fixed fixed object 10 to the substrate 53.
[0040] This acceleration sensor has the arms 311-314 with narrow width of face, and the mass section 32 in which the stoma 33 was formed in the shape of a matrix by the large area, the end of arms 311-314 is connected to the fixed object 10, and it connects with the mass section 32 which consisted of movable objects 11, and the other end is constituted so that the mass section 32 may be supported with each arms 311-314 and the fixed object 10.
[0041] If the opening 72 is formed in the base of arms 311-314, and the base of the mass section 32, therefore the mass section 32 and a substrate 53 are in a non-contact condition and acceleration is added, each arms 311-314 bend with the weight of the mass section 32, and it is constituted so that the mass section 32 can move in the vertical direction.
[0042] Therefore, if the mass section 32 carries out vertical migration of the capacitor of an parallel monotonous mold which arms 311-314 and the mass section 32 are constituted by the movable object 11, and is constituted by the mass section 32 and the substrate 53, he is trying for capacity value to change.
[0043] On the other hand, the circuit section 3 has the electric element of a large number formed into the structure layer which constitutes the fixed object 36, and the measuring circuit is formed of those electric elements.
[0044] Moreover, the electrode pad 37 which is an electrode for external connection of a large number formed of patterning of a metal thin film in the circuit section 3, The thin film wiring 38 which performs electrical installation between electric elements and electrical installation between an electric element and the electrode pad 37 is formed. It connects with the above-mentioned measuring circuit through the thin film wiring 38, and the mass section 32 is constituted so that capacity change of the capacitor in which the measuring circuit is formed with the mass section 32 and a substrate 53 can be detected.
[0045] The structure of such a combinational device 2 is explained with the manufacture approach with reference to drawing 2 (a) - (e) drawing 3 (f) - (i) and drawing 4 (j) - (m). In addition, in the cross-section structure, a part of each important section of circuit section 3' shown in drawing 1 and micro machine section 4' is shown.
[0046] First, two silicon single crystal wafers with which silicon oxide was formed in the front face are prepared. In one silicon single crystal wafer, the diffusion layer 52 of a conductivity type opposite to the wafer is formed in the predetermined field, and silicon oxide is formed in the near front face in which the diffusion layer 52 is formed.
[0047] The silicon oxide of such two silicon single crystal wafers is stuck, and one wafer 50 is formed with a direct conjugation method.
[0048] Then, the silicon single crystal layer of the direction in which the diffusion layer 52 was formed is ground, and it is made thin to predetermined thickness, and considers as the surface structure layer 54. Another side makes a substrate 53 constitute from a condition as it is. Moreover, the silicon oxide used on the occasion of direct junction is taken as the sacrifice layer 51.
[0049] The usual semi-conductor process of using for integrated-circuit manufacture is applied to this wafer 50, and the electronic-circuitry elements containing a bipolar transistor are formed. If the part is shown all over drawing, after forming the thin silicon thermal oxidation film 56 on the structure layer 56, into the structure layer 54 (field shown by sign 3') used as the circuit section, two or more diffusion layers 44 will be established (a diffusion layer 44 also contains the thing of a different conductivity type), and many electric elements 41 will be formed (this drawing (b)).
[0050] The depth comparable as the thickness of the structure layer 54 is made to diffuse the diffusion layer 45 of the same conductivity type as the structure layer 54 in the structure layer 54 (field shown by sign 4') used as the micro machine section at this time. Moreover, a detached core 47 is formed into the structure layer 54 used as the circuit section, and each electric element 41 is made to separate electrically with a diffusion layer 52.
 [0051] In the condition, the insulator layer 56 which consists of silicon

oxide is formed in structure layer 54 front face, patterning of the insulator layer 56 is carried out, and openings 57 and 58 are formed in the predetermined location on the structure layer 54 which serves as the micro machine section an electric element 41 top, respectively (this drawing (c)).
[0052] In the condition, by the sputtering method, the metal thin film 60 which consists of an aluminum thin film is formed completely (this drawing (d)), and the protective coat 64 which changes from a titanium tungsten thin film to the front face of the metal thin film 60 is continued, and membranes are formed completely (this drawing (e)).
[0053] Next, patterning of a protective coat 64 and the metal thin film 60 is carried out together, and area forms the electrode pad 37 of a large rectangle configuration, and the thin film wiring 38 with narrow width of face. At this time, the protective coat 64 and the metal thin film 60 on the structure layer 54 used as the movable object 11 are removed.
[0054] If the thin film wiring 38 is electrically connected to a diffusion layer 45 or a diffusion layer 44 through openings 57 and 58, between electric element 41 comrades and between an electric element 41 and the electrode pads 37 will be electrically connected by the thin film wiring 38. Moreover, the movable object 11 of the micro machine section can be electrically connected to an electric element 41 or the electrode pad 37 with the thin film wiring 38 (drawing 3 (f)).
[0055] If the passivation film 67 which consists of a silicon nitride is deposited on a front face (this drawing (g)) and the passivation film 67 on the micro machine section and the electrode pad 37 is subsequently removed from the condition, on the micro machine section, an insulator layer 56 will be exposed, and a protective coat 64 will be exposed on the electrode pad 37 (this drawing (h)).
[0056] If the mask film 66 which consists of silicon oxide is made to deposit on the front face, on the structure layer 54 of micro machine circles, the mask film 66 will be formed on the insulator layer 56 which similarly consists of silicon oxide. Moreover, on the electrode pad 37 of circuit circles, the mask film 66 is formed on the protective coat 64 which consists of a titanium tungsten thin film, and is formed in another side and other parts of circuit circles on the passivation film 65 which consists of a silicon nitride film (this drawing (i)).
[0057] Next, if patterning of the mask film 66 and an insulator layer 56 is performed together and opening 70 is formed in micro machine circles, silicon structure layer 54 front face (diffusion layer 45) will be exposed to the opening 70 base (this drawing (j)).
[0058] If the mask film 66 is located, the front face of fields other than opening 70 uses the mask film 66 for a mask and anisotropic etching is performed, the structure layer 54 exposed to opening 70 base will be etched. The anisotropic etching stops in the place which sacrifice layer 51 front face exposed to the base of opening 70 (this drawing (k)). The structure layer 54 which constitutes arms 311-314 and the mass section 32 is fabricated by etching of the structure layer 54 from such opening 70.
[0059] Subsequently, if the whole is immersed in the fluoric acid buffer solution (BHF), etching of the sacrifice layer 51 will be started from the base of opening 70. The etching advances also in the longitudinal direction of the sacrifice layer 51 (side etching), and the sacrifice layer 51 in the base of the structure layer 54 is corroded from a side face.
[0060] this time -- the facet among the structure layers 54 -- in a product or the part formed in narrow, although the sacrifice layer 51 under that base is removed completely, in a large area or the part formed broadly, the sacrifice layer 51 remains in the bottom of the base of the structure layer 54, and the structure layer 54 of that part is fixed to a substrate 53 by the sacrifice layer 51. The fixed object 10 is constituted by such a large area or the structure layer 54 formed broadly, and the sacrifice layer 51 of the base.
[0061] When small area or the structure layer 54 formed in narrow is connected to the structure layer 54 which constitutes the fixed object 10, an opening 72 is formed between the structure layer 54 and a substrate 53, and the movable object 11 is constituted from a place where the sacrifice layer 51 under a base was removed by the structure layer 54 of the part (this drawing (l)).
[0062] The structure layer 54 of the above-mentioned arms 311-314 has narrow width of face, since the end is connected to the structure layer 54 which constitutes the fixed object 10, the sacrifice layer 51 is removed and arms 311-314 are constituted by the movable object 11.

[0063] Since the other end of arms 311-314 is connected to the four corners of the mass section 32, the opening 70 which becomes the structure layer 54 of the mass section 32 with a stoma 33 is arranged in the shape of a matrix, width of face of structure layer 54 the very thing is narrowed and the sacrifice layer 51 under a base is removed as mentioned above, the mass section 32 is constituted by the movable object 11.

[0064] Thus, since the mask film 66 which consisted of silicon oxide as well as the sacrifice layer 51 is also removed together in case the fixed object 10 and the movable object 11 are formed by etching of the sacrifice layer 51, on the thin film wiring 38 of the circuit section, the passivation film 65 is exposed to a front face, and a protective coat 64 is exposed on the electrode pad 37. In the micro machine section, although an insulator layer 56 is exposed with removal of the mask film 66, since the insulator layer 56 consists of silicon oxide, an insulator layer 56 will also be removed and the front face (diffusion layer 45) of the structure layer 54 exposes it.

[0065] After etching the sacrifice layer 51, the protective coat 64 which exposed the whole to electrode pad 37 front face when immersed in hydrogen peroxide solution is removed, and the metal thin film 60 is exposed to a front face (this drawing (m)).

[0066] Then, if a substrate 80 is fixed on the conductive bases 80, such as a leadframe, in the condition of having electrical installation with the rear face of a substrate 53 and a lead and the electrode pad 37 of the conductive base 80 are connected by wire bonding, the combinational device 2 by which the capacitor which consists of a substrate 53 and the mass section 32 was connected to the measuring circuit in the circuit section 3 formed on the same substrate 53 can be obtained.

[0067] In this case, wire bonding may not be carried out for the conductive base 80 and the electrode pad 37, but wire bonding of the lead etc. may be carried out to the conductive base 80.

[0068] Although the above-mentioned thin film wiring 38 was formed in the circuit section 3, as the sign 39 of drawing 1 shows, you may form in the micro machine section 4. It is made to connect with a diffusion layer 45 electrically through the thin film wiring 38, or direct continuation may be carried out to a diffusion layer 45, and you may connect with the mass section 32 electrically, and with the thin film wiring 38, it may connect with the measuring circuit in the circuit section 3, and the electrode 39 in the micro machine section 4 may be used as the electrode.

[0069] Although the above made the electric element 41 separate by pn junction, what is depended on the various separation approaches, such as dielectric separation, is contained in this invention. Moreover, as for the electric element 41 formed in the circuit section 3, electric elements, such as a bipolar transistor, an MOS transistor, a resistance element, and a capacitor, are contained widely.

[0070] Moreover, although the above explained the combinational device of the acceleration sensor which detects capacity change of the capacitor formed between a movable object and a substrate, this invention is not limited to it. For example, the combinational device which measures capacity change of the capacitor formed between a movable object and a fixed object, and the combinational device which, in addition to this, has micro machines other than a sensor are included widely.

[0071] Although the above-mentioned example connected the structure layer 54 and electric element 41 of the movable object 11 through the thin film wiring 38, it may be connected according to the diffusion layer in the structure layer 54.

[0072] Although silicon oxide was used for the mask film 66 at the above-mentioned protective coat 64 using the titanium tungsten thin film, it is not limited to it. In case a protective coat 64 removes the sacrifice layer 51, it should just be a thin film which is not removed with the etching solution (this example fluoric acid buffer solution), but when a titanium tungsten thin film is used as a protective coat 64, since the hydrogen peroxide solution which is the etching solution does not etch the usual passivation film, such as a silicon nitride, it is convenient.

[0073] A selection ratio should just be a high ingredient in case the silicon structure layer 54 is etched about the mask film 66. However, when silicon oxide is used, since it is removed together in case the sacrifice layer 51 is removed, it is convenient.

[0074] Furthermore, although the above-mentioned passivation film 67 was constituted from a silicon nitride film, it is not limited to it again. However, since the passivation film is exposed as mentioned

above in the case of removal of the sacrifice layer 51 when the mask film 66 is constituted from silicon oxide, the ingredient which is not etched with fluoric acid buffer solution is desirable.

[0075] In addition, although the above-mentioned example explained the case of a SOI substrate, that by which the structure layer was manufactured not using a silicon single crystal but using the wafer which consisted of polish recons is also contained in this invention.

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